Monetary Transmission:
What do we Know and How Can we Use it? *

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1. Introduction

Since the pioneering work of Milton Friedman (1961), the existence
of a considerable and varying time lag between the actions by the cen-
tral bank in adjusting its policy instruments and the effects on the tar-
get variable is generally acknowledged. Because of these lags, the
monetary policy maker must take a forward-looking approach in his
decision making. Central elements in the latter process include a fore-
cast of the target variable over some horizon, and views on the trans-
mission mechanism between the adjustment in the policy instrument
and the policy goal (Freedman 1996). For a central bank to achieve its
ultimate objective, it would be preferable to know in detail how
monetary policy affects non-financial activity, that is inflation and
real output. In practice, however, we have only imperfect knowledge
of the interactions that take place within various chains of the mone-
tary transmission mechanism.

   The purpose of this paper is to survey the possible channels of
monetary transmission, and to discuss the implications for the prepara-
tion of monetary policy of the imperfect knowledge the policy maker
has of the transmission mechanism. The paper is organised as follows.

The next Section contains a brief description of important concepts used in the formulation of monetary policy. This provides us with the necessary tools to discuss in more detail the various channels through which monetary policy decisions affect policy targets in Section 3. It is concluded in this Section that there exists considerable ambiguity regarding the various transmission channels actually operating in the economy. Economic theory provides us with some basic notions, but the transmission mechanism in practice is determined by structural, behavioural and institutional factors. In reaction to this ambiguity we propose, in Section 4, a framework for preparing a strategy of monetary policy which entails using a number of different models in order to gain a fuller insight in various chains of the transmission mechanism. Section 5 concludes.

2. Monetary policy: some conceptual issues

It is now fairly generally accepted, at least among policy makers, that price stability should be the medium- to long-run goal of monetary policy. The fundamental reason to pursue price stability is that inflation is economically and socially costly. This hypothesis is well documented (see, for example, Fischer 1994 and 1996, Barro 1995). The costs of inflation depend on the institutional structure of the economy, in particular the tax system, and on the extent to which the inflation rate has been anticipated (Feldstein 1996). Regarding the concept of price stability, we follow Goodhart and Viñals (1994) and Bernanke and Mishkin (1997) and interpret price stability as achieving and maintaining a low and stable rate of inflation. Correspondingly, we define the inflation rate as the ultimate target variable for monetary policy.

Monetary policy makers have at their disposal certain operational targets of economic policy, i.e. variables that are directly under the control of the monetary authorities, who have some discretion regarding the selection of particular variables to use as operational targets. None of these operational targets is directly related to economic welfare. The purpose of controlling them is simply to influence other variables which are more directly related to welfare. To achieve these opera-

tional targets, central banks have at their disposal certain sets of instruments, especially reserve requirements, standing facilities and open market operations. Below we will use the label instrument in a rather broad sense, pertaining to the operational target as well as the actual instruments available to achieve these targets.

Intermediate variables are like operational targets in the sense that they have no direct significance for social and economic welfare; their main importance (and the reason why the monetary authority may attempt to target these variables) lies in the alleged relationship with the ultimate target variable. The main difference between operational and intermediate variables is that while the former are narrowly controlled by the policy maker, the latter cannot generally be influenced with great precision. This is because intermediate variables are determined by the behaviour of private sector agents as well as of policy makers. The question then naturally arises as to why the policy maker should target an intermediate variable instead of directly focusing on realising the ultimate target. The answer lies in the dynamic and stochastic environment in which the policy maker operates. As elaborated by, e.g., B. M. Friedman (1996), the fact that policy actions and their economic effects are separated both by time and by behavioural processes (see below) implies that grounding monetary policy on intermediate targets provides a coherent way of taking the consequences of (unavoidable) unexpected developments into account. A second argument for a role of intermediate targets is in using them as signals to the public about monetary policy intentions and thus as instruments to influence inflation expectations (Bernanke and Mishkin 1992, Poole 1994).

The task facing policy makers is then to choose particular intermediate targets and to develop procedures for intertemporal variation of these targets such that the economy is most likely to attain the best feasible combination of time paths for the ultimate-target variable. The way in which policy makers resolve the issues of choice and variation of intermediate targets constitutes the monetary strategy. The monetary strategy followed manifests itself in monetary policy decisions, i.e. decisions concerning the choice of, and intertemporal variation in, operational targets so as to achieve the projected outcome for the intermediate target variable.

A monetary strategy is thus the foremost important element of any monetary policy. But a prerequisite for a successful monetary strategy is an understanding of the relationship between operational targets

and ultimate target variables (Romer and Romer 1996). A shorthand commonly used to describe the complex chains of behavioural causation between these two types of variables is that of the monetary transmission mechanism. The latter mechanism describes how private-sector agents respond to the policy actions of the monetary authorities, and how the monetary authorities and the private sector then interact. Important factors conditioning the behaviour of economic agents (and the policy maker, for that matter) are institutional and structural factors, in particular those determining the functioning of markets, the financial behaviour of firms and financial intermediaries and the composition of their balance sheets (Mankiw and Romer 1991, BIS 1995). These factors are not constant, but subject to ongoing change. Moreover, economic agents operate in an uncertain environment, so that their decisions are based on expectations regarding factors relevant for those decisions, such as the behaviour of the monetary policy maker (see Section 4). The strategy followed by the monetary policy maker must take these kind of changes and expectations into account. Knowledge of the transmission process can thus have an important bearing on the preparation of monetary policy (Mishkin 1996). It is therefore necessary to discuss this transmission process in more detail.

3. The monetary transmission mechanism

The monetary transmission mechanism consists of several channels, all of them interlinked and each of them comprising of several stages. Central to these different views are alternative conceptions regarding the structural and institutional factors mentioned above, more specifically the functioning of credit, labour and product markets. To illustrate the working of the monetary transmission mechanism and the role of these factors, we consider it useful, for presentational purposes, to highlight the following elements:[1] first, the influence of changes in the instrument variables on the cost of finance; second, the influence of changes in the cost of finance on expenditure decisions of

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[1] The transmission mechanism is a dynamic process, in that it represents a sequence of events taking place at successive moments in time. The ordering below reflects the timing of this sequence.

private-sector agents, i.e. on non-financial activity; third, the pass-through of changes in non-financial activity to output and inflation.

Before discussing in more detail these elements, which are depicted visually in Chart 1, we make three observations. First, underlying this division of the transmission mechanism into separate stages, is the conception that markets do not necessarily clear instantaneously. If, on the other hand, all markets did always clear, the transmission mechanism would be fairly trivial: a change in the instrument variable would immediately lead to a compensating change in the price level, without having consequences for output, and maintaining the classical dichotomy.[2] Second, in addition to the nominal rigidities just mentioned, we explictly allow for the possibility of real rigidities, by exploring the relations between a change in the instrument variable of monetary policy and non-financial activity under credit market imperfections. The latter are a result of asymmetric information between lenders and borrowers (Stiglitz and Weiss 1981, Bernanke 1983, Bernanke and Blinder 1988). To position these observations in macroeconomic theory, new classical or real business cycle theory would reject both kinds of rigidities, 'traditional' Keynesian economic theory would accept nominal but does not mention real rigidities, and new Keynesian economics would accept both nominal and real rigidities (Mankiw and Romer 1991).[3] Third, it is more or less generally accepted that changes in the instrument variable in the long run only affect prices, so that money is neutral in the long run. Possible short-run barriers to full and immediate nominal adjustment ('nominal' rigidities) are not inconsistent with this view. Whether the same applies to situations in which supply and demand do not come together because of market failures ('real rigidities') is not clear. The literature on credit market imperfections, for example, does not address this issue, because of the basically static nature of the analysis. Usually it is (implicitly) assumed that these real rigidities are not long-run phenomena, implying long-run money

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[2] This line of reasoning implicitly follows traditional real business cycle theory (Kydland and Prescott 1982). However, the assumption of market clearing does not necessarily imply a trivial transmission mechanism. Counter examples are the stochastic general equilibrium models which incorporate money, for example within the cash-in-advance framework (Cooley and Hansen 1995).

[3] New Keynesian economics is not without its problems, either. For example, their explanations of rigidities are mainly short term. Moreover, their theoretical foundation of real rigidities seems somewhat stronger than the explanation of nominal rigidities, which are relevant for monetary policy.

neutrality. This issue could have important policy implications, how-ever. If real rigidities do not vanish in the long run, and monetary policy consequently is non-neutral in the long run, this is a new ele-ment in the discussion regarding central bank independence. As this discussion is beyond the scope of this paper, we will not take it up here.

CHART 1

MAIN CHANNELS OF THE MONETARY POLICY TRANSMISSION PROCESS
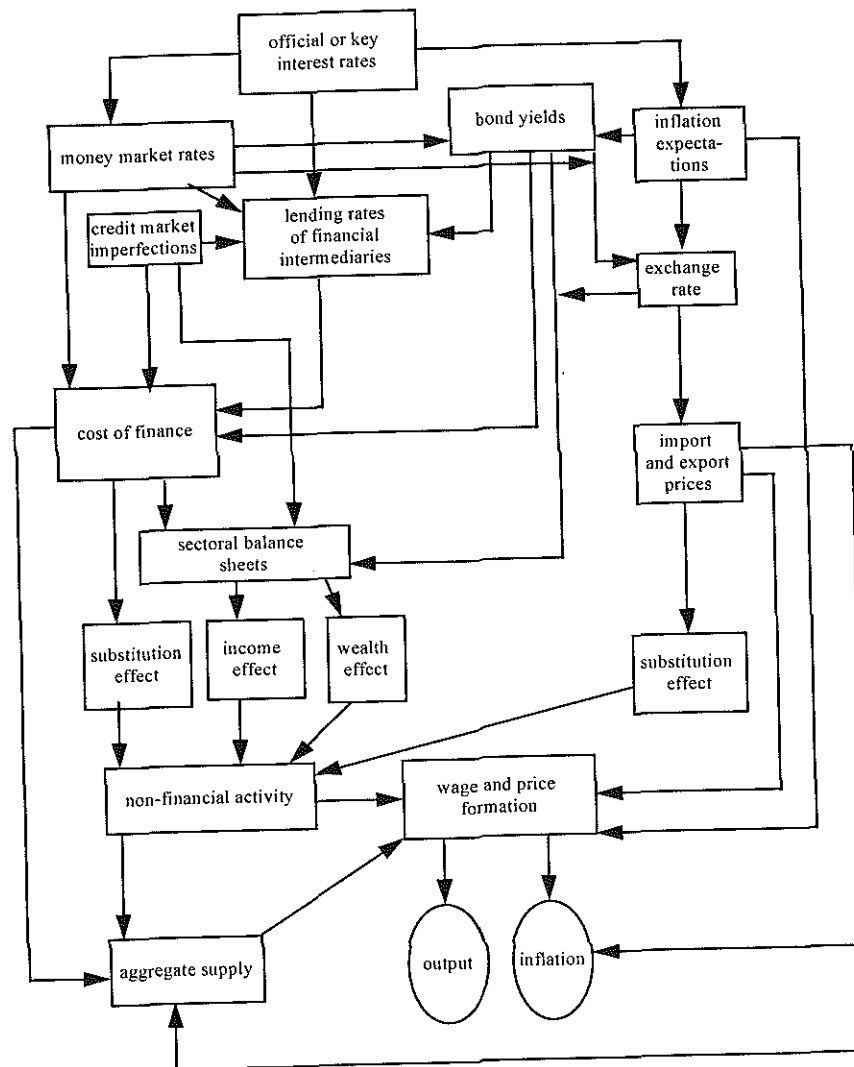
3.1. *Examining the first stage*

The presumption underlying this stage is that the monetary authority exercises power over economic behaviour of private-sector agents by influencing the financial (opportunity) cost relevant to the spending de-cisions of these agents. The typical operational target used by central banks is the overnight rate, which the central bank broadly determines through its influence on bank reserves (Crockett 1994). According to BIS (1994), the passthrough from these overnight rates to short-term market interest rates is fairly complete in most industrialised countries. We take this to imply that the central bank can, for all intents and pur-poses, control the short-term market interest rate. This position is rela-tively unchallenged (see also Bernanke and Blinder 1992, Mauskopf 1990). However, the level of short-term market interest rates affects only a proportion of the financing of expenditure of households and firms. The private sector also finances part of its spending at longer-term rates on the capital market as well as through financial intermedi-aries (and through other means like retentions and equity issues), and the cost of borrowing from these sources is only indirectly influenced by the current level of money market rates. Important determinants of the impact of changes in the instrument variable (the overnight rate) on the cost of finance thus include the substitutability between different forms of finance, the pass-through of changes in market interest rates to bank lending and deposit rates and the impact of changes in short-term interest rates on long-term interest rates.

The substitutability between different forms of finance and the responses to market rates of lending charges applied by financial insti-tutions is to an important extent dependent on the functioning of credit markets. In a neo-classical financial environment without fric-tions and asymmetric information, that is, a world in which the Modi-gliani-Miller (1958) theorem holds, agents in the private sector can, at market interest rates, borrow and lend whatever amounts are necessary to achieve their desired spending patterns. The absence of information imperfections between suppliers and users of funds implies that the substitutability between internal and external financing sources and be-tween different forms of external finance, such as intermediated and non-intermediated credit, is perfect (BIS 1994). In this case, financial in-termediaries play a purely passive role in the monetary transmission process, namely the channeling of short-term saving to longer-term in-

vestment projects. If bank assets and liabilities have identical characteristics to other borrowing and saving instruments, such as bonds, then bank and non-bank instruments will trade at the same price (assuming risk neutrality). The pass-through between market interest rates and bank rates is immediate and complete (Dale and Haldane 1993). Financial prices in this perfect capital market allocate financial quantities optimally. In this case, interactions between financial variables and non-financial activity can be reduced and simplified to interactions between interest rates and non-financial activity. The main implication of this view is that interest rate channels operating through the cost of capital are extremely important in the monetary transmission mechanism (Taylor 1995).

Notwithstanding the unrealistic character of the underlying paradigm of perfect capital markets, the interest rate (price) channel remained the dominant channel in post-war discussions regarding the transmission mechanism. Both Keynesians and monetarists adhered to this paradigm, for example (Purvis 1992). Both schools of thought of course differed on the importance for the transmission mechanism of the various assets which are alternatives to holding money balances. The standard Keynesian view that focusses on only one asset price, 'the' interest rate (see Taylor 1995), was criticized by the monetarists, who stressed the importance of a multi-asset 'portfolio balance' specification of asset equilibrium (Tobin 1961 and 1969, M. Friedman 1959 and 1970, Friedman and Schwartz 1963, Brunner 1971, Foley and Sidrauski 1971, Sargent 1979). As emphasized by Meltzer (1995), this equilibrium determines not a single interest rate, but a vector of rates, representing the yields on bonds, equity and other assets. The transmission of changes in the instrument variables to the ultimate targets operating through this array of imperfect substitutes for money balances is sometimes denoted as the asset price channel (Mishkin 1995 and 1996).

It was not until the analysis of Akerlof (1970) that the traditional interest rate channel of monetary transmission received considerable criticism from a strand of research that rejects the equilibrating nature of the credit market. Financial prices in this alternative view do not clear the credit market (Bernanke and Gertler 1995). This view of the transmission process is also known as the credit channel.[4] In this case

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[4] For a discussion of this channel see, for example, Kashyap and Stein (1994) and Hubbard (1994b).

the efficient functioning of the market for credit is hindered by asymmetries in information between borrowers and lenders, resulting in principal-agent problems (Oliner and Rudebusch 1996). These problems lead to endogenous and varying credit conditions which help to shape the transmission of monetary policy decisions through the economy. As recognised by, *inter alia*, Kashyap, Stein and Wilcox (1993), this uncertainty generates a potential important role for financial intermediaries which specialise in gathering and distilling agent-specific information. The implication is that financial intermediaries, usually banks, play a unique role in the monetary transmission process, acting as an interface between the policy decisions of the central bank and non-financial activity. Decisions of financial institutions regarding the size of their balance sheets and the yields paid on their assets and liabilities now play an active role in the transmission of monetary policies. Because financial institutions obtain a portion of their funds from instruments subject to reserve requirements, open market operations, which alter the quantity of reserves, may affect the opportunity cost of funds to those institutions beyond their impact on market interest rates. That is, financial quantities (the availability of credit) play an important role in the transmission mechanism. In this view of monetary transmission the impact of changes in market rates (price) on the cost of finance (which now is quantity- as well as price-related) depends on various factors, the most important being the behavioural characteristics of the economy, expressed in e.g. the balance sheets of private sector agents. In addition, the economy's financial structure such as, for example, the relative importance of financing at short-term versus long-term rates (which, among other things, depends on the prevalence of fixed versus variable rate financing) is important, as well as the relative importance of direct versus intermediated financing (BIS 1995). Mishkin (1996) argues that there exists compelling empirical evidence illustrating the importance of credit channels for the monetary transmission mechanism. However, a recent review of the literature on the credit channel (Berk 1998a) notes that there are severe identification problems in empirically confirming the importance of this channel of the transmission mechanism. Despite these empirical problems, we find the asymmetric information view of credit market imperfections that lies at the core of the credit channel analysis appealing, since it is a theoretical construct that has proved to be highly useful in explaining many other important phenomena.

The responses of longer-term interest rates to movements in short-term rates are most easily explained under the paradigm of perfect capital markets, as discussed above. If all financial assets other than money are perfect substitutes, there exists only one relative asset price, 'the' interest rate. The difference between the short-term interest rate and the long-term interest rate, or, more generally, changes in market interest rates along the maturity spectrum will reflect fully the current level and expected future path of short-term interest rates. This is the so-called expectations theory of the term structure (Modigliani and Shiller 1973), a theory that in general receives little empirical support. As is argued in, *inter alia*, Berk (1998b), capital markets are not perfect, financial market participants are not risk-neutral and consequently the differences between interest rates of different maturity will not only reflect expectations of future changes in short-term rates, but also risk premia.[5]

3.2. *Examining the second stage*

The impact of changes in the cost of finance (which now includes quantity as well as price-related variables) on non-financial activity depends on various factors (Bank of England 1990). First, changes in the cost of finance are relevant for the selection of new investment projects or portfolio investment, thereby affecting the opportunity cost of real expenditure decisions. This effect is called the substitution effect. Second, changes in the cost of finance lead to changes in average rates on outstanding contracts, modifying incomes and cash flows and hence constraints on spending. This effect is denoted as the income effect. Third, changes in the cost of finance affect the value of certain assets, such as housing, equities or government stocks. These values, in turn, have an impact on wealth perceptions, which influence spending. Moreover, this so-called wealth effect influences the ability to borrow and the willingness to lend. Referring to the discussion in the previous Section, it

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[5] This empirical rejection of the expectations theory of the term structure causes problems for the traditional interest rate channel of monetary transmission. This is because monetary policy admittedly has its strongest influence on short-term interest rates, and the imperfect pass-through of short-term interest rates into long-term rates is at odds with the observed large effects monetary policy has on purchases of long-lived assets (Bernanke and Gertler 1995). This puzzle provided additional stimulus for research on the credit channel to help explain the potency of monetary policy.

can be seen that the magnitude of these factors *inter alia* depends on imperfections in the credit market. The exact impact of changes in the cost of finance on non-financial activity therefore depends on structural features such as balance sheet structure, in particular the relative and absolute size of liabilities at floating interest rates, either of the private or of the public sector (BIS 1995).

A final factor through which changes in monetary policy instruments influence non-financial activity operates through the exchange rate (Menon 1995). Under flexible exchange rates, a change in the domestic instrument variable *ceteris paribus* elicits movements in the exchange rate. This will, in turn, have an impact on non-financial activity via, firstly, the pass-through to import and export prices and, secondly, the impact of changes in import and export prices on the current account. An alternative interpretation of the exchange rate channel is given by Berk and Winder (1994). They show that pegging the exchange rate to a stable low-inflation foreign currency is a means to achieve price stability in the domestic country. Price stability is achieved through a simple disciplining mechanism (Svensson 1994, Pech 1994). First, if a higher domestic than foreign inflation occurs, it leads to a domestic real exchange rate appreciation, that is, domestic goods become more expensive relative to foreign goods. This reduces the demand for domestic goods and induces a cyclical downswing which will reduce the domestic inflation subsequently to the same long-run level as the foreign one (note that we have assumed imperfect price adjustment). Second, wage- and price-setting behaviour will to some extent anticipate these consequences of too high wage and price increases, which will make a higher domestic inflation less likely to occur in the first place. However, pegging the exchange rate is not a substitute for monetary stability and credibility at home. In fact, a peg is only sustainable when it is credible, and credibility is partly determined by domestic policies (see Obstfeld and Rogoff 1995).

3.3. *Examining the third stage*

Our discussion of the first and second stages of the monetary transmission mechanism showed that, because of real rigidities in the form of credit market imperfections, monetary policy can influence non-

financial activity not (only) through interest rates but (also) through the availability of credit. In addition, the extent to which changes in non-financial activity generated by changes in the instrument variables are translated into changes in prices and output, respectively, depends largely on the behaviour of wage and price setters. In general, the greater the degree of nominal wage and price flexibility, the more changes in non-financial activity affect prices and not output. Wage and price behaviour, in turn, is influenced by inflation expectations as well as by institutional factors. Following the introduction of the rational expectations hypothesis (Muth 1961) to macroeconomics by Lucas (1972), Sargent (1976) and Sargent and Wallace (1975), expectational effects are related to concepts like credibility and reputation of the policy maker. The institutional framework in which this interaction between the policy maker and the private sector takes place stresses factors which inhibit the continuous clearing of markets. Rational expectations are thus compatible with non-market clearing due to various (institutional) barriers to rapid adjustment of prices and wages (Fischer 1977, Blinder 1991, Ball and Mankiw 1994). New Keynesian economics provide explanations as regards the causes of these rigidities (Gordon 1990, Mankiw and Romer 1991). In this respect a number of suggestions have been made, which can be summarised as follows. The most notable structural factors contributing to the sluggishness of price adjustments are legal and institutional barriers to price adjustments (such as rent controls) and monopolistic or oligopolistic competition in product markets. But also in a competitive environment, price inertia may result from the existence of menu costs in changing prices or from a desire by firms not to damage long-term relationships with clients by frequent variations in prices. As regards wage rigidities, explanations also focus on factors hindering competition, such as regulatory impediments to wage adjustments (e.g. minimum wages), the influence of unions and generous unemployment benefit schemes.[6] On the other hand, even where competition is fierce but information is distributed asymmetrically, there may be a desire of both firms and workers to have longer-term working relationships entailing an implicit insurance against excessive wage vola-

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[6] For a recent discussion of rigidities in the labour market, see Akerlof, Dickens and Perry (1996).

tility, or firms may refrain from downward wage adjustments in order not to jeopardise employee motivation and labour productivity. Moreover, from the hysteresis literature (Cross 1988), wage rigidities causing unemployment persistence are explained with insider-outsider and duration theories of the wage bargaining process.

3.4. *Expectations and the transmission mechanism*

From the literature initiated by Kydland and Prescott (1977) and Barro and Gordon (1983), it is clear that expectations of the public will ultimately determine the ability of the policy maker to achieve the ultimate target. From this it becomes clear that expectations play a crucial role in the monetary transmission mechanism. In turn these expectations are dependent on the public's assessment of the credibility of central bank behaviour. The latter concept is fundamental to modern analysis of monetary policy in general and central banking in particular (Fischer 1994). Assessing alternative monetary policy strategies in terms of accountability and transparency, for example, as advocated by Shigehara (1996) and European Monetary Institute (1997), can be motivated with the concept of credibility.

As should be clear from the previous discussion, expectations play an important role in each stage of the transmission mechanism. For example, expectations of economic agents largely determine the relationship between interest rates under the control of the policy maker and the rates most relevant for non-financial activity. Moreover, expectations of economic agents play a key role in the international interdependence of important variables in various chains of the transmission mechanism, and partly determine the behaviour of wage and price setters, who ultimately determine the transmission of policy decisions into prices and output. The formation of expectations by itself is a manifestation of the existence of uncertainty. We now turn to a discussion of the implications of the latter observation for monetary policy.

4. Implications for the foundations of monetary policy: a multi-model approach

From the preceeding discussions, it follows that a central conception for monetary policy is the transmission mechanism. As will be discussed further below, there exists considerable ambiguity regarding this mechanism. This ambiguity should, in our view, have consequences for the appropriate methodology used by the monetary policy maker.[7] The traditional approach, of relying on a structural macroeconomic model to describe all aspects of the transmission mechanism and to answer every possible question, is less suitable. Instead, a framework for preparing monetary policy in which a range of models is used to help analyse several pieces of information seems more appropriate. This so-called multi-model approach allows the policy maker to grapple with the role of specific interactions in a comprehensible way. The choice of model is determined by the specific problem to be analysed. We believe that policy analysis using tools specifically designed to cope with the problem at hand increases the chances of finding stable relationships more than an analysis using a general (structural) model in which the specific circumstances can only be (imperfectly) translated. See Boeschoten, van Els and Bikker (1994) and Whitley (1997) for applications of our proposed multi-model approach.

Illustrative of the ambiguity regarding monetary transmission are the well-known long and variable lags between actions by the policy maker in adjusting its instrument and the effects on inflation (M. Friedman 1961, Blinder 1997). Traditional analyses of the policy-making process distinguish between different causes of these lags. They include a data collection lag, a recognition lag, an implementation lag and an impact lag. As a discussion of these determinants is fairly standard and can be found in any textbook (see, for example, Hubbard 1994a, pp. 684-85), we will refrain from it here.[8] Instead we focus on a

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[7] In this paper, we concentrate on the implications of the ambiguity regarding the transmission mechanism for the preparation of monetary policy. A discussion of the consequences of this ambiguity for the strategy followed by the monetary policy maker is beyond the scope of this paper.

[8] In addition to these factors, Blinder (1997) argues that the fact that monetary policy decisions in many countries are made by a committee instead of a single person also contributes to the lags in the effects of monetary policy.

less mechanical analysis of the lags in the transmission mechanism. This analysis forms the main motivation of our proposed multi-model strategy. It stresses the following factors in causing the ambiguity of the transmission mechanism (and the long and variable lags): the theoretical uncertainty regarding the proper description of the transmission mechanism, the complexity of this mechanism, and the uncertainty with which economic agents participating in the transmission mechanism have to deal with. We discuss them in turn.

The analysis presented in the previous Section indicates that there is no such thing as 'the unique' monetary transmission mechanism; there are various theoretical views. Given this theoretical uncertainty, it seems advisable for the policy maker to view the transmission mechanism from different angles, using models tailored for the problem at hand. The same argument applies to the complexity of the behavioural processes that together form the transmission mechanism. This complexity contributes to the long and variable lags. For instance, the rigidities mentioned in Section 3 are important causes of the lags in monetary transmission, and the variability in these lags could result from differences in rigidities across countries and, due to institutional changes, in time (see Bryan and Gavin 1994). Moreover, differences between countries in structural factors, such as the foreign influence on the domestic economy, as well as the ongoing changes in these structural factors, play a role (Britton and Whitley 1997).

Changing perceptions of economic agents regarding the behaviour of the policy maker and the workings of the various stages of the process of monetary transmission are additional determinants of the long and variable lags. Such changes imply a certain amount of unpredictability in the behaviour of these agents. This uncertainty can be given two interpretations. The first relates to situations (of Knightian risk) in which the frequency approach to probability and uncertainty is valid. In this case, individual behaviour can be analysed with theories of expectations formation. Variable lags are consistent with most of these theories, including the rational expectations hypothesis. Under this hypothesis, variability of individual behaviour could result from heterogenous information sets and from new information becoming available at irregular intervals. Both factors could also account for variable lags in the second interpretation of uncertainty, in which the frequency approach as a general theory of uncertainty is rejected. This case, valid in situations of Knightian uncertainty and which we denote as fundamen-

tal uncertainty, is especially relevant for monetary economies as it provides a theoretical rationale for holding money (see Hoogduin 1991) and van der Lecq 1996).[9] The existence of fundamental uncertainty acknowledges the limitations on the cognitive capacity of economic agents. These limitations imply that agents are not able to optimize over the entire range of possible actions, as implicit in the frequency approach (Lucas 1977, p. 223). They introduce uncertainty in selecting most preferred alternatives, which will tend to produce errors and surprises. Such mistakes are by their nature unpredictable and erratic. Fundamental uncertainty can therefore not be removed; it is impossible to reduce all uncertainty to the probabilistic kind. People may acquire new information, deep structural parameters such as preferences, technology and risk aversion may change. These changes are an endogenous element of the transmission process, and can affect economic decisions at any moment. Relations between variables in the various stages of the transmission process and expectations may therefore be subject to ongoing change. This interpretation of inherent uncertainty in the transmission process could well explain why, despite a considerable amount on research regarding the lags in the effects of monetary policy (Tucker 1966; Tanner 1969, 1972 and 1979; Howrey 1969; Waud 1975; Dieckheuer 1974; Smith 1972), we are lacking and probably will never succeed in developing a theory that consistently and coherently explains these lags: agents simply cannot decipher all of the complexity of the decision problems they face.

It should be added that the existence of fundamental uncertainty is not at odds with the primary goal of our analysis, which is to provide the policy maker with *stable* relationships between key variables in different chains of the transmission mechanism. Fundamental uncertainty does not necessarily imply instability of behaviour, and therefore does not imply the rejection of the use of models per se.

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[9] The distinction, due to Keynes (1936), between the formation of expectations and the incompleteness of the information on which these expectations are based, is of importance here (see also Hicks 1974). The latter (a manifestation of fundamental uncertainty) determines the confidence economic agents attach to the former. The lower this confidence, the higher the uncertainty with which agents are confronted. In the face of uncertainty, economic agents may prefer not to commit themselves for too long a period (that is, make irreversible spending decisions), and delay their decisions until the moment they are sufficiently confident to rely on their knowledge (Hoogduin 1991, p. 65). The existence of uncertainty thus creates a need for liquidity, and money is the most liquid of assets.

There exist counterforces which make for stability and make people confident that sensible decisions can be made. As argued by Heiner (1983), the more uncertain people are, the better predictable their behaviour is, because they employ the same rule in many different situations. Rules, conventions and laws, in combination with existing institutions, traditions and experience invoke a tendency towards stability in behaviour in the face of fundamental uncertainty. This is because allowing flexibility to react to information or to select actions will not necessarily improve performance if there is (fundamental) uncertainty about how to use that information or about when to select particular actions. Rules and conventions, among others, introduce some type of rigidity or inflexibility in adjusting to different situations, thereby limiting behaviour to a smaller set of repertoires that can be readily administered.

A number of clarifying remarks are in order. First, using several models is by no means an attempt to obscure the policy makers' view of the transmission mechanism. It is merely the implication of the view that this mechanism is too complex to be captured in even a large model. Neither does this general framework imply rejecting the use of structural models in monetary policy; we merely propose supplementing the policy analysis with models of the reduced-form kind (Whitley 1997). Second, the proposed underpinning of monetary policy has to be distinguished from the monetary policy strategy. Where the former pertains to the methods used to analyse information, the latter relates to the judgement by the policy maker of the information analysed, that is, the policy (re-) action. Both are related, of course, as the strategy followed in part determines the kind of questions to be analysed. But the policy maker will ultimately be judged by the success of his strategy in terms of achieving the ultimate target, and not on the analysis that underlies his judgement. Third, using a range of models implies the possibility of different outcomes, perhaps suggesting various policy reactions. How is the policy maker to choose? The answer lies in the policy strategy followed, which should provide him with a guidepost or benchmark for attributing weights to different outcomes. Whilst economic theory and quantitative information aid the policy maker by providing him with basic notions, the choice of strategy is part of knowledge that is very difficult to make explicit. This is because this choice reflects the reaction of the policy maker to fundamental uncertainty regarding the process of monetary transmission. As noted by

Heiner (1983), such uncertainty requires behaviour of, in this case, the policy maker to be governed by mechanisms that restrict the flexibility to choose potential actions. These mechanisms, of which the monetary policy strategy is an example, simplify behaviour to less complex patterns, which are easier to observe and to predict.[10] The choice of mechanism, that is of monetary strategy, is partly determined by institutions, traditions, experience, rules, conventions and laws. Monetary policy could, in this respect, at least in part be considered an art.

4.1. *Models to be used in the multi-model approach*

In the previous Section we argued that the monetary policy maker is in need of a flexible methodology, in which not just the information relevant according to a particular theory that is incorporated in a structural model (Baumgartner, Ramaswamy and Zettergren 1997) is analysed.[11] The so-called reduced form models provide this flexibility. They study the behaviour of variables considered to be important in (channels of) the transmission mechanism under consideration, without imposing restrictions based on supposed *a priori* knowledge of the dynamic linkages between the variables. The models are reduced in the sense that they do not require explicit estimation of all the behavioural parameters of the participants in the transmission mechanism (Sims 1982). For a recent discussion of the reduced form methodology in a monetary policy context, see Leeper, Sims and Zha (1996). Both the structural and reduced form approaches can best be viewed as complementary (Palm 1988). This can be seen most easily for a prominent example of the reduced form approach, the so-called vector autoregression (VAR) analysis (Sims 1980 and 1982). As is well known (see Hamilton 1994, for a formal exposition), the equations in a VAR-analysis can be viewed as the reduced form equations of the variables in a structural model.

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[10] This line of reasoning has clear connections with the literature on rules versus discretion in monetary policy strategy (see, *inter alia*, B.M. Friedman 1993 and 1994).

[11] Other disadvantages of the structural modelling approach include the incredibility of the identifying restrictions used to obtain equation-by-equation interpretations of structural models (Sims 1980). Moreover, it may not always be possible to construct these models, due to lack of data or prohibitive costs. Structural models are relatively expensive to construct and to maintain, and the estimation may entail computational inefficiencies (Knot 1996).

The reduced form is therefore a condensed version of the underlying structural form.

Reduced forms are not without their problems, either. First, the main advantage of the reduced form over the structural model, that there are no *a priori* restrictions that limit the interdependences of the variables included in the model (Garretsen and Swank 1998), is, ironically, at the same time one of the major weaknesses of this approach: convincing identifying restrictions are hard to come by. Another drawback of reduced forms is the impossibility of making direct inferences on hypotheses derived from economic theory.[12] Although one can, in principle, deduce the structural form from the reduced form given the proper identifying restrictions (Cramer 1988), in practice these restrictions are unavailable. In that case there is no one-to-one correspondence between the reduced and the structural form, and a particular reduced form may be compatible with different structural models (representing different economic theories). These limitations of reduced forms illustrate the need to complement them with other models, for example of the structural kind (Woodford 1994), but also monetary general equilibrium models. The latter are especially useful since they are less prone to the Lucas critique (Bolt and Folkertsma 1996).

5. Concluding comments

A central concept in conducting monetary policy is the process of monetary transmission. We have argued that the policy maker is confronted with considerable uncertainty regarding the functioning of this process in practice. There are several reasons for this, the most important being that structural, institutional and behavioural factors to a large extent determine the transmission mechanism. In reaction to this uncertainty, a framework for preparing monetary policy which consists of using a number of models to study various chains of the transmission mechanism seems more appropriate than the tradi-

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[12] However, see Basmann (1972) and Kloek (1988) for a critical assessment of the role played by theory in macroeconomic structural models.

tional position of relying solely on large-scale structural models. This framework exploits various kinds of information, and should be directed towards providing the policy maker with stable, economically interpretable, relationships which can then be used for policy purposes. In trying to achieve this goal, we have to deal with the fact that the theoretical knowledge of the monetary transmission mechanism and the lags in this mechanism is far from perfect and that the data, which have to be used to put this limited knowledge to the test empirically, are deficient. Given these problems, it seems advisable not to burden the policy analysis with unduly rigid priors. Without being constrained by a theory that may or may not be plausible, the reduced form methodology allows us to pick up unexpected patterns and correlations. The reduced form approach thus provides us with shortcuts, where structural or general equilibrium models present a broad overview. The former are therefore useful complements to the latter, and can be especially useful when specific questions are to be addressed, or when new information has to be evaluated in a relatively short time span. The speedy processing of new information is especially important given the uncertainties surrounding the linkages in the transmission mechanism. These uncertainties make it necessary for the policy maker to continuously assess the effect of the change in instrument in different stages of the process of monetary transmission, and, when necessary, to make further policy adjustments.

Having argued that the traditional informational basis of the monetary policy maker should be broadened by adding reduced form or other types of models to the traditional large-scale structural models, many questions remain. Which structural models should be included? Which models in reduced form? Which elements of the transmission mechanism discussed in the previous Section are to be specified in the models? These daunting topics, which are just beginning to attract attention (see, for example, Leeper, Sims and Zha 1996), are left for future research.

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